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The Impact of Cryptocurrency and Electronic Money Use On The Circulating Money Supply and Monetary Stability in Indonesia

Yolanda Sari [1], Etik Winarni[2]
[1] Fakultas Ekonomi dan Bisnis, Universitas Jambi, Jambi, Indonesia
[2] Fakultas Ekonomi dan Bisnis, Universitas Muhammadiyah Jambi, Jambi, Indonesia

Email: yolandasari2711@gmail.com

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ABSTRACT

The purpose of this research is to analyze the long-term and short-term impacts of the use of cryptocurrency and electronic money on the money supply (M2) in Indonesia, as well as to analyze the long-term and short-term impacts of the use of cryptocurrency and electronic money on monetary stability (exchange rates) in Indonesia. The research method used is quantitative descriptive analysis with the Vector Error Correction Model (VECM) using the Eviews application and secondary data in the form of monthly data from 2011 to 2023 obtained from the official websites of Bank Indonesia and Finance. This study utilizes data on cryptocurrency transaction values and electronic money transaction values in Indonesia by analyzing the VECM model, which can observe the long-term and short-term impacts of the use of digital money on the money supply and monetary stability, in this case, viewed through the Indonesian exchange rate. The research results indicate that there is a one-way causality between electronic money and cryptocurrency, but not the other way around, and there is a one-way causality between the money supply and cryptocurrency, with the money supply as the dependent variable influencing cryptocurrency. The results of the VECM estimation indicate that in the long term, electronic money has a negative and sifnificant impact on the money supply. Meanwhile, the short-term estimation shows that both cryptocurrency and electronic money significantly influence the money supply, but their effects are dynamic and vary based on different lags. The long-term estimation with the exchange rate as the dependent variable shows that cryptocurrency does not have a significant impact on the exchange rate, while in the short term, both cryptocurrency and electronic money have a negative and significant effect on the exchange rate.
Keywords: *Cryptocurrency, Electronic Money, Money Supply (M2), Exchange Rate, VECM*

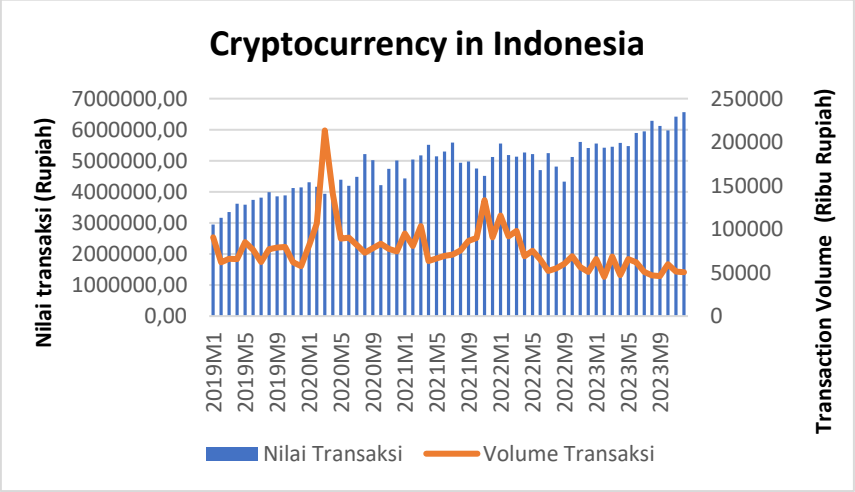
INTRODUCTION

Money is a legitimate and legally recognized instrument used as a means of transaction in the economy for the exchange of goods and services in accordance with applicable regulations. In its development, the form of money has changed from of money has changed from physical commodities like gold and silver to paper money issued by the government and central banks. Over time, technology and innovation in financial systems have influenced the way people use money. The use of non-crash currencies, especially those based on technology, can accelerate the circulation of money and influence monetary stability in Indonesia. Monetary stability is a condition where the exchange rate of the rupiah against the dollar remains stable and inflation can be controlled. Bank Indonesia aims to achieve and maintain the stability of the rupiah's value. This stability encompasses two aspects: the stability of the currency's value against goods and services, as well as stability against the currencies of other countries.

In recent years, the use of digital money, which provides an alternative to cash in various economic transactions, both in the form of cryptocurrencies and electronic money, has rapidly grown worldwide, including in Indonesia. The development of information and communication technology has facilitated the adoption of digital currency in various transactions, from daily payments to investments and as assets.

Digital currency offers varoius advantages, including ease of transactions, lower transaction costs, and broader access for individuals or communities that previously lacked access to traditional financial services. The acceleration of digital payment sistems is driving a shift in societal preferences towards digitalization, which previously relied more on cash. The increase in cashless transactions leads to transparency in the circulation of money and can reduce the demand for cash (Yi Lin Forest, J; Ying, 2018); (Popovska-Kamnar, 2014).

Cryptocurrency is a digital currency that uses cryptographic technology for its security, making it difficult to counterfeit, and its transactions must be conducted online via the internet. Each transaction is encrypted using a specific cryptographic algorithm (Mulyanto, 2015). Unlike traditional currencies, cryptocurrencies are not issued by a central authority and cannot be manipulated by governments. Initially, cryptocurrencies were not regarded as a medium of exchange representing digital currency, but their rapid development has made them widely recognized. Here is the table of cryptocurrency values and transaction volumes in Indonesia.



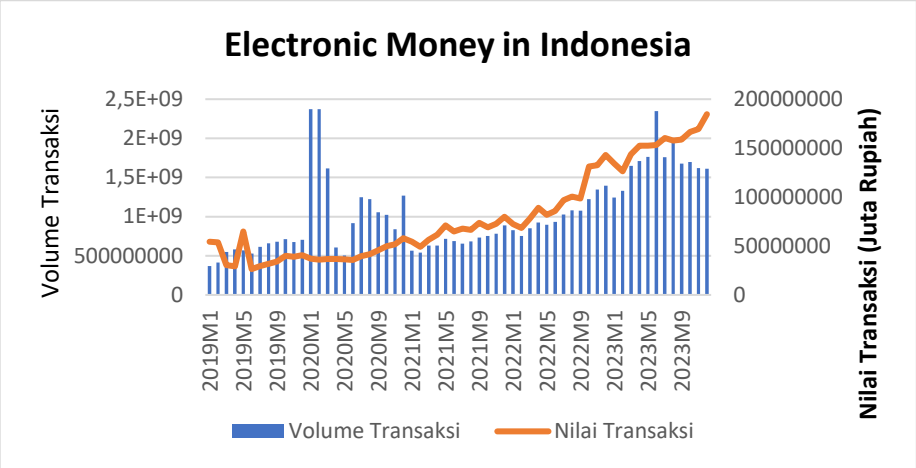
Source: Finance, 2024 (processed data)

Image 1. Development of Value and Volume of Cryptocurrency Transactions in Indonesia Period 2019.1-2023.12

Based on Figure 1, the volume of cryptocurrency transactions fluctuates each month and shows a generally declining trend. The highest transaction volume during the period from 2019 to 2023 was in March 2020, amounting to 213,426,000 transactions. Subsequently, it fluctuated and tended to decline until Desember 2023. In contrast, the value of cryptocurrency transactions fluctuated and tended to increase: from 2019 to 2023, the value of cryptocurrency transactions continued to rise until December 2023, reaching Rp.6,566,121.60. The growth rate of cryptocurrency year by year is quite significant. The development of cryptocurrency with the highest value at present is Bitcoin. The term used for the very rapid price changes is volatility. When volatility is high, it means that prices change very quickly over a short period of time. The faster the price changes occur, the higher the volatility of Bitcoin. The demand for Bitcoin and other cryptocurrencies has surged, partly because Bitcoin and others are predicted to shine even brighter in the future, leading the global community to be interested in investing in Bitcoin and other cryptocurrencies.

One of the other digital currencies that is equally important and continues to grow each year is electronic money. Electronic money, according to the Bank for International Settlements (BIS), is a product of stored or prepaid value owned by an individual, where a certain amount of money has been stored in an electronic medium and used as a means

of transaction (Bank Indonesia, 2015). The development of electronic money in Indonesia began in 2007 with the issuance of Bank Indonesia Regulation No. 07/52/PBI/2005. At that time, electronic momey was still considered a part of payment instruments using cards (APMK). It was only in 2009 that Bank Indonesia issued Regulation No. 11/12/PBI/2009 on Electronic Money, which established that electronic money is one of the alternative non-cash payment instruments, alongside debit and credit cards. In electronic money, the value of money is stored electronically using chips or servers (Abidin, 2015). The development of transaction volume and value of electronic money fluctuates and tends to increase in Indonesia, as seen in the following Figure 2.



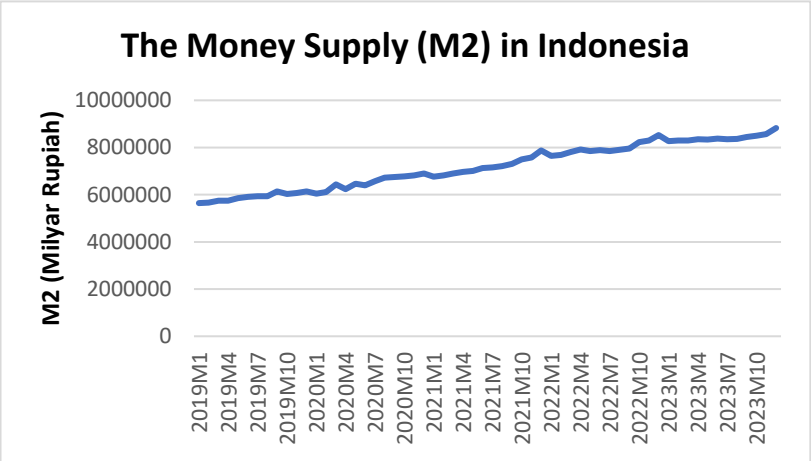
Source: Bank Indonesia, 2024 (processed data)

Image 2. Development of Electronic Money Value and Transaction in Indonesia Period 2019.1-2023.12

According to Figure 2, it can be seen that the volume of electronic money transactions in Indonesia is fluctuating, but the highest transaction volume occured in February 2020, amounting to 2,372,349,430 transactions, while the highest transaction value occured in December 2023, totaling IDR 184 trillion.

From Figures 1 and 2, it is evident that the increase in digital money transaction volume, both cryptocurrency and electronic money, surged significantly in 2020, which was caused by the effects od Covid-19 that led many people to predominantly use non-cash or digital money, as electronic money is relatively easy, fast, and efficient to use with low transaction costs. However, the increased use of digital money also raises important questions regarding its impact on monetary policy and economic stability. One aspect that needs to be studied is how the use of digital money affects the money supply and monetary stability. The money supply is one of the key indicators in monetary policy as it is directly related to inflation, interest rates, and economic growth. Meanwhile, monetaru stability, which is reflected in exchange rate stability, is crucial for maintaining confidence in the currency and macroeconomic stability.

The amount of money circulating in Indonesia can be viewed from two perspectives: the money supply in a narrow sense (M1) and the money supply in a broad sense (M2) (Cahyono, A. P; Hidayat, A; HW, A. D; Firmansyah, A; Fadly, 2016). Below is a figure showing the development of the money supply in Indonesia as viewed in a broad sense (M2).



Source: Bank Indonesia, 2024 (processed data)

Image 3. Money Supply (M2) in Indonesia for the Period 2019.1-2023.12

Based on Figure 3 above, it can be seen that the money supply (M2) has increased every year. In January 2019, the money supply was Rp.5,644,985.00 billion and continued to increase until December 2023, reaching Rp.8,826,531.02 billion. The increasing amount of money in circulation (M2) means that more people are saving and using money. The rise of instriments such as cryptocurrensies and electronic money indicates that the public has more options for saving and using their money. The use of electronic money facilities cashless transactions, which are often faster and more efficient compared to cash transactions. This encourages an increase in the amount of money in the form of savings and time deposits that are included in the money supply (M2).

The use of cryptocurrency and electronic money can also impact monetary stability, particularly the Indonesia exchange rate. The development of the Indonesia exchange rate fluctuates each year, as shown in the following Figure 4.

Source: Bank Indonesia, 2024 (processed data)

Image 4. Indonesian Exchange Rate Period 2019.1-2023.12

The development of the Indonesian rupiah from 2019 to 2023 has undergone various changes influenced by domestic and international economic and financial factors. At the beginning of 2019, the exchange rate of the Rupiah was Rp.14,163.14, facing pressure due to global factors such as trade tensions between the US Federal Reserve. However, along with the adjustment of monetary policy by Bank Indonesia and the stabilization of external factors, the Rupiah experienced a recovery throughout 2019. The year 2020 became a year of challenges due to the COVID-19 pandemic, which resluted in a global helath crisis and widespread economic impact. The Rupiah exchange rate was initially significantly affected by market ucertainty, but with the rapid policy response

from Bank Indonesia and fiscal stimulus, the Rupiah managed to strengthen again in the second half of 2020, with the exchange rate in December 2020 at Rp.14,173.09. From 2021 to 2023, the movement of the Rupiah has remained relatively stable, with a value of Rp.15,513.37 in December 2023. The focus in 2023 is on domestic policies that support sustainable economic growth and exchange rate stability.

Cryptocurrencies tend to be highly volatile, which can lead to exchange rate instability if many cross-border transaction are conducted using cryptocurrencies. The exchange rate of the rupiah could become unstable if there are significant movements in cryptocurrency prices. If the use of cryptocurrency and electronic money increases significantly, the demand for the rupiah in daily transactions could decrease. This could reduce domestic demand for the local currency, which might put pressure on the exchange rate of the rupiah if it is not balanced by a sufficiently large demand in the foreign exchange market. The policy response by Bank Indonesia regarding the use of cryptocurrecies and electronic money can also affect monetary stability. If regulations are considered too strict or too loose, this can affect market perception and exchange rate stability. The use of cryptocurrency is also associated with the risks of financial crime and money laundering. If not properly regulated, this could disrupt monetary stability, particularly the exchange rate, through illegal activities that suddenly affect capital flows.

The novelty of this research is that we can observe the long-term and short-term impacts of the use of cruptocurrency and lectronic money on both the money supply (M2) and monetary stability (exchange rates) simultaneously, allowing us to formulate appropriate monetary policies in response to the economic conditions in Indonesia.

Cryptocurrency and Electronic Money

Cryptoptocurrency is a digital currency where transactions are conducted online. Unlike printed paper currency, cryptocurrency is designed by solving complex mathematical algorithms based on cryptographic priciples. This cryptographic technology is used to ensure that the currency cannot be easily duplicated or transferred without the permission of its rightful owner. According to FATF (Financial Action Task Force), virtual currency is a digital representation of value that can be transacted virtually and serves as (1) a medium of exchange; and/or (2) a unit of account; and/or (3) a store of value. However, this virtual currency is not recognized as a legitimate means of payment in any jurisdiction (Kelly, 2018).

According to the Bank for International Settlements, electronic money is a product that stores a certain value of money in electronic form. Simply put, electronic money is cash whose value has been transferred into a digital medium, so electronic money is also included in the components of the money supply in society (Usman, 2017).

Money Supply

The money supply is the total amount of money held by the public or the money available in the hands of the public at a specific time (Anggraini, 2016). The amount of money in circulation in Indonesia is regulated by Bank Indonesia Regulation No.17/8/FBI/2015, which pertains to the regulation and supervision of monetary policy (Bank Indonesia, 2015). There are two definitions of the money supply, namely narrow money (M1) and broad money (M2): (1) Narrow money (M1) includes cash and demand deposits held by the public. Cash refers to the currency issued by Bank Indoensia, consisting of coins and banknotes that circulate in society and can be used for cash transactions. Demand deposits are the public's saving in the form of checks, money orders, and giro accounts held in commercial banks. This savings falls into the category of circulating money because it can be used by the public at any time for transactions. (2)

Broad money (M2) includes M1 as well as quasi-money, which encompasses currency, demand deposits, and quasi-money. Quasi-money refers to the public's deposits in commercial banks, such as savings accounts, time deposits, and foreign currency accounts. Quasi-money is included in the category of money supply because these savings and time deposits can be converted into cash for transactions. In Indonesia, M2 includes all time deposits and savings in rupiah held in commercial banks, regardless of the amount of the deposits. The money supply in this broad sense is also known as the liquidity of the economy or M2 (Muchtar, Bustari; Rahmidani, Rose; Siwi, 2016).

Monetary Stability (Exchange Rate)

One of the main indicators to assess monetary stability is the exchange rate. The exchange rate of a currency, often referred to as the rate against other currencies, reflects the market's confidence in a country's economy. According to Brigham & Houston (2011), the exchange rate is the number of units of one currency that can be exchanged for one unit of another currency. The exchanfe rate reflects the relative price between two currencies and is used in various transactions, including investments. Another definition of exchange rate id the price of one unit of foreign currency in domestic currency, or it can also be said to be the price of domestic currency against foreign currency. For example, the exchange rate of the Rupiah against the US Dollar (USD) is the price of one USD in Rupiah (Rp), or it can also be interpreted as the price of one Rupiah against one USD (Simorangkir & Suseno, 2014).

Vector Error Correction Model (VECM)

VECM is an analytical model that can be used to understand the behavior of a variable in the short term in relation to the long term, as a result of a permanent shock (Ajija, Schochrul R; Sari, Dyah W; Setianto, Rahmat H; Primanti, 2011). The assumption that must be met in VECM analysis is that all independent variables must be stationary. This is characterized by all residuals being white noise, meaning they have a mean of zero, constant variance, and no correlation among the independent variables. The stationarity test is conducted by testing for the presence of a unit root in the variable using the Augmented Dickey-Fuller (ADF) test. This stationarity test is important because the presence of a unit root will lead to spurious regression. To address the issue of spurious regression, one can approach it by differentiating the endogenous and exogeneous variables. Thus, a stationary variable of degree I(n) will be obtained.

Data stationarity assessed solely through differentiation is considered insufficient; the presence of cointegration or the short-term and long-term relationships within the model must also be taken into account. The detection of the presence of cintegration can be done using the Johansen method or the Engel-Granger method. If the variables are not cintegrated and stationary at the same order, then standard VAR can be applied, and the results will be identical to OLS. However, if testing proves the existence of a cointegration vector, then ECM can be applied for a single equation or VECM for a system of equations.

METHODS

This research uses quantitative descriptive analysis with secondary sata in the form of mothly data from cryptocurrency variables, electronic money, the money supply (M2), and monetary stability. The monetary stability variable used in this study is the middle exchange rate, with the research period spanning from 2011 to 2023. The data source is obtained from the official websites of Bank Indonesia and Finance. The method or model used in this research is the VECM, which can observe the patterns of

relationships between variables in both the long term and the short term. The analysis method used in this research is the VECM analysis model. The stages in VECM analysis are as follows:

1. Unit Root Test

The VECM modelling is based on non-stationary time series data that are cointegrated. To assess the stationarity of the data, the unit root test can be used with the ADF test statistic. The ADF t-statistic > all critical alpha values (5% and 10%) can be interpreted as the data not being stationary, but if the ADF t-statistic < all absolute critical values or the p-value is less than the significance alpha level, then it can be interpreted as the data being stationary.

2. Lag Optimal

The determination of the optimal lag length is a stage in the lag examination and will be used in subsequent analysis to determine the parameter estimates of the VECM model (Widarjono, 2017).

3. Cointegration Test

The next test is the cointegration test. The cointegration test is interpreted as a long-term equilibrium relationship among variables (Faisal & Ichsan, 2020). If the trace test > critical value at α or p-value < significance level α, then there is a cointegration relationship.

4. Causal Analysis

The purpose of causal analysis is to examine short-run causality and long-term relationships (long-run causality). Short-term causality analysis for each variable can use Granger causality tests based on the Wald test, which is distributed as chi-square, or the F test as an alternative. Meanwhile, the long-term relationship analysis between variables in the VECM modelling can be observed through the coeffecients of the error correction term (ECT), based on the sign and results of the t-test from the OLS method (Lutkepohl, 2013).

5. Model Estimation and Structural Analysis

The estimates from the VECM model are similar to the estimates and structure of the VAR model. In the VAR model, analysis is conducted using impulse response and variance decomposition (Lutkepohl, 2013). The analysis of impulse response aims to observe the effects of each variable (endogenous) when subjected to a shock or impulse, while variance decomposition analysis aims to predict the contribution of each variable (the percentage of variance of each variable) caused by changes in specific variables within a system.

RESULTS AND DISCUSSION

Before entering the VECM analysis stage, the data is first tested for classical assumptions by checking whether the data is free from autocorrelation or not. The results can be seen in the following Table 1.

Table 1. Classical Assumption Test (Autocorrelation Test)

Estimate Equation	Probability Obs*R-Squared	There is Autocorrelation
M2 = C(1) + C(2)*KRIPTO + C(3)*UE	0.0000	Yes
KURS = C(1) + C(2)*KRIPTO + C(3)*UE	0.0000	Yes

Source: Data processed by Eviews, 2024

From Table 1 above, it is known that the probability of Obs R-Squared is 0.0000 < 0.05, which leads to the conclusion that the assumption of the autocorrelation test has not been met or has failed the autocorrelation test due to the presence of autocorrelation in the model at a 95% confidence level.

Since the data contains autocorrelation, the next step is to conduct the VECM analysis, with the following steps:

1. Unit Root Test

The first procedure is to perform the unit root test using the Augmented Dickey Fuller test, as shown in Table 2 below.

Table 2. Unit Root Test

Variable	Critical Value (α)	Level		First Difference	
		ADF-*Statistic*	*p-value*	ADF-*Statistic*	*p-value*
M2		1.349658	0.9988	-16.92803	0.0000
	5%	-2.880211		-2.880211	
KURS		-1.588980	0.4858	-11.07504	0.0000
	5%	-2.880336		-2.880336	
KRIPTO		1.173536	0.9979	-14.11293	0.0000
	5%	-2.880336		-2.880336	
UE		4.144856	1.0000	-12.75492	0.0000
	5%	-2.880336		-2.880336	

Source: Data processed by Eviews, 2024

Description:

M2 : Money supply (M2) of Indonesia

KURS : The Middle Exchange Rate of Indonesia

KRIPTO : Transaction Value of Cryptocurrency in Indonesia

UE : Transaction Value of Electronic Money in Indonesia

Based on Table 2, the values of the money supply (M2), the middle exchange rate, the value of cryptocurrency transaction, and the value of electronic money transaction are still not stationary at the level stage because the p-values of each variable are greater than α (5%), meaning the data no longer contains a unit root or is stationary.

2. Lag Optimal

In determining the optimal lag, various values are used such as Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Criterion (HQ). The table below shows the results of the optimal lag testing.

Table 3. Optimal Lag Test with M2 as the Dependent Variable

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-12305.52	NA	3.46e+68	166.3314	166.3921	166.3560
1	-11565.76	1439.535	1.78e+64	156.4562	**156.6992***	156.5549
2	-11548.11	33.62569	1.58e+64	156.3393	156.7646	156.5121
3	-11521.63	49.39249	1.25e+64	156.1030	156.7106	**156.3499***
4	-11511.72	18.07398	1.24e+64	156.0908	156.8806	156.4117
5	-11505.21	11.60440	1.28e+64	156.1245	157.0966	156.5194
6	-11498.07	12.45789	1.32e+64	156.1495	157.3039	156.6186
7	-11484.39	23.28545	1.24e+64	156.0864	157.4230	156.6294
8	-11472.83	**19.20872***	**1.20e+64***	**156.0518***	157.5707	156.6689

Source: Data processed by Eviews, 2024

Table 4. Optimal Lag Test with Exchange Rate as the Dependent Variable

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-8359.451	NA	2.40e+45	113.0061	113.0669	113.0308
1	-7653.976	1372.818	1.96e+41	103.5943	103.8373	103.6930
2	-7642.278	22.28819	1.89e+41	103.5578	103.9831	103.7306
3	-7605.148	69.24190	**1.30e+41***	103.1777	**103.7852***	**103.4245***
4	-7597.086	14.70884	1.31e+41	103.1903	103.9802	103.5112
5	-7589.452	13.61758	1.34e+41	103.2088	104.1809	103.6038
6	-7582.860	11.49077	1.39e+41	103.2414	104.3957	103.7104

7	-7575.154	13.12086	1.41e+41	103.2588	104.5954	103.8019
8	-7559.555	**25.92798***	1.30e+41	**103.1697***	104.6885	103.7868

Source: Data processed by Eviews, 2024

Note: the asterisk (*) indicates the selected lag

The purpose of optimal lag testing is to adress the issue of autocorrelation in the VAR system so that autocorrelation does not reappear. Based on Table 3 and Table 4, it can be seen that the LR, FPE, and AIC criteria indicate that the optimal lag length is at lag 8 for Table 3, while the FPE, SC, and HQ citeria indicate that the optimal lag length is at lag 3 for Table 4.

3. Cointegration Test

In this study, the method used for the cointegration test is the Johansen cointegration test, which examines the trace statistic to determine whether there is a long-term relationship between the variables being studied. If there is cointegration, then the stages of VECM analysis can proceed.

Table 5. Cointegration Test with M2 as the Dependent Variable

Hypothesized No. of CE(s)	Eigenvalue	Trace-statistic	Critical Value (5%)	Probability
None*	0.242547	53.43212	24.27596	**0.0000**
At most 1*	0.079778	12.59646	12.32090	0.0450
At most 2	0.002546	0.374775	4.129906	0.6035

Source: Data processed by Eviews, 2024

Table 6. Cointegration Test with Exchange Rate as the Dependent Variable

Hypothesized No. of CE(s)	Eigenvalue	Trace-statistic	Critical Value (5%)	Probability
None*	0.222424	46.00890	24.27596	**0.0000**
At most 1	0.049744	7.769684	12.32090	0.2551
At most 2	9.20E-05	0.014137	4.129906	0.9227

Source: Data processed by Eviews, 2024

Note: the asterisk (*) indicates the selected lag

Based on Table 5 and Table 6 above, the Trace statistic value in Table 5 for None and At most 1 is greater than the critical value at a 5% significance level, with a probability value less than 5% significance, indicating the presence of two cointegration equations. In Table 6, there is one cointegration equation for None, where the Trace-statistic value is greater than its critical value, with a probability value less than 5%. Thus, both the variables M2, KRIPTO, and UE, as well as the variables KURS, KRIPTO dan UE, show that both cointegration tests have a long-term equilibrium relationship and long-term movements. This also means that the research can continue using the VECM model.

4. Causality Analysis (Granger Causality)

Table 6. Granger Causality Test with M2 as the Dependent Variable

Null Hypothesis :	Obs	F-Statistic	Prob.
NT_KRIPTO does not Granger Cause NT_EMONEY	148	2.33136	0.0225
NT_EMONEY does not Granger Cause NT_KRIPTO		1.03259	0.4149
JUB does not Granger Cause NT_EMONEY	148	1.07591	0.3839
NT_EMONEY does not Granger Cause JUB		1.40743	0.1991
JUB does not Granger Cause NT_KRIPTO	148	1.12723	0.3492
NT_KRIPTO does not Granger Cause JUB		2.76498	0.0074

Source: Data processed by Eviews, 2024

Table 7. Granger Causality Test with Exchange Rate as the Dependent Variable

Null Hypothesis :	Obs	F-Statistic	Prob.
NT_KRIPTO does not Granger Cause NT_EMONEY	153	2.09486	0.1034
NT_EMONEY does not Granger Cause NT_KRIPTO		0.84710	0.4702

KURS does not Granger Cause NT_EMONEY	153	0.42374	0.7363
NT_EMONEY does not Granger Cause KURS		0.89319	0.4463
KURS does not Granger Cause NT_KRIPTO	153	1.71942	0.1656
NT_KRIPTO does not Granger Cause KURS		0.67681	0.5676

Source: Data processed by Eviews, 2024

In Table 6, it is shown that the electronic money variable statistically significantly affects cryptocurrency, as indicated by its probability value being less than 0.05. Conversely, the cryptocurrency variable does not significantly affect the electronic money variable, meaning there is a one-way causality between the electronic money variable and cryptocurrency. This may be due to the fact that electronic money is more widely used by the general public for daily transactions such as payments in stores, online, transportation, and so on, while cryptocurrency is still in the early stages of adoption, making its role smaller in the real economy and more often used as a speculative asset. Many cryptocurrency users buy and sell crypto through platforms that require the use of electronic money. This makes transactions in the crypto world dependent on conventional payment tools like electronic money to enter or exit the crypto market. The variable of cryptocurrency transaction value does not statistically affect the variable of money supply; however, the variable of money supply significantly affects the variable of cryptocurrency transaction value, as indicated by a probability value smaller than 0.05. This means there is a one-way causality between the variable of cryptocurrency transaction value and the money supply. Cryptocurrencies are generally not considered part of the official monetary system and do not directly contribute to the money supply in the economy. Because cryptocurrencies are still treated as speculative assets rather than a primary medium of exchange, their fluctuations do not directly affect the money supply. On the contrary, the money supply reflects all forms of money circulating in the official economic system, which can influence liquidity and the behavior of cryptocurrency investors.

Table 7 shows that there is no mutual influence between electronic money and exchange rates; similarly, there is no mutual influence between cryptocurrency and exchange rates. Electronic money and cryptocurrency, as well as their relationship with exhange rates, do not influence each other because they operate in relatively separate ecosystems. Electronic money is generally used for everyday domestic transactions and is more influenced by domestic monetary policy, while cryptocurrency is more speculative in nature and not integrated with the official financial system. Exchange rates (foreign currency values) are more relevant for unternational transactions, and since electronic money and cryptocurrencies are often used in local or speculative contexts, exchange rate fluctuations do not directly impact their transaction volumes.

5. Model Estimation and Structural Analysis

Table 8. Results of Long-Run VECM Estimation with M2 as the Dependent Variable

Variable	Coefesien	t-Statistic	t-Tabel
DNT_EMONEY(-1)	-5.97E-08	[-3.28152]	1.97539
DJUB(-1)	1.52E-09	[5.27921]	

Source: Data processed by Eviews, 2024

Table 9. Results of Short-Run VECM Estimation with M2 as the Dependent Variable

Variable	Coefesien	t-Statistic	t-Tabel
CointEq1	0.014900	[2.53237]	1.97539
	473067.4	[2.40727]	
	12238600	[5.95450]	
D(DNT_KRIPTO(-1))	-0.216084	[-2.42635]	
D(DNT_KRIPTO(-2))	-0.411141	[-4.46229]	
D(DNT_KRIPTO(-4))	-0.300095	[-3.00365]	

D(DNT_KRIPTO(-6))	-0.314180	[-3.02947]	
D(DNT_EMONEY(-1))	-0.333203	[-3.68628]	
D(DNT_EMONEY(-2))	-0.238717	[-2.49280]	
D(DNT_EMONEY(-4))	0.271527	[2.69602]	
D(DJUB(-1))	-0.412467	[-4.57172]	
D(DJUB(-4))	-0.206968	[-2.38650]	
D(DJUB(-8))	-0.224740	[-2.69115]	

Source: Data processed by Eviews, 2024

Table 8 shows that the long-term VECM estimation results indicate that the electronic money variables at lag 8 has a negative and significant effect on the money supply variable (M2) because the t-statistic value is greater than the t-table value. This suggests that the use of electronic money tends to reduce the money supply (M2) in the long term. Based on Table 9, in the short term, the cryptocurrency and electronic money variables influence the money supply (M2) with a t-statistic value greater than the t-table value. This indicates the dynamic effect of changes in transaction of the cryptocurrency and electronic money variables on the money supply (M2). Some lags of these variables show negative significance, meaning that in the short term, an increase in the use of electronic money and cryptocurrency reduces the money supply (M2), but at a certain lag, there is actually a positive effect. This indicates that short-term effects are more complex and vary depending on the response time of each variable.

Table 10. Results of Long-Run VECM Estimation with Exchange Rate as the Dependent Variable

Variable	Coefesien	t-Statistic	t-Tabel
DNT_KRIPTO(-1)	10871447	[1.08476]	1.97539
DKURS(-1)	2.53E+09	[1.08663]	

Source: Data processed by Eviews, 2024

Table 11. Results of Short-Run VECM Estimation with Exchange Rate as the Dependent Variable

Variable	Coefesien	t-Statistic	t-Tabel
CointEq1	0.033658	[5.69364]	1.97539
D(DNT_EMONEY(-1))	-0.445407	[-5.21659]	
D(DNT_EMONEY(-2))	-0.416439	[-4.93487]	
D(DNT_KRIPTO(-1))	-0.203274	[-2.46122]	
D(DNT_KRIPTO(-2))	-0.359497	[-4.50767]	
D(DKURS(-1))	0.287677	[3.40876]	
D(DKURS(-2))	-0.350087	[-4.21603]	

Source: Data processed by Eviews, 2024

Based on Table 10, the long-term VECM estimation results show that the cryptocurrency variable at lag 3 has a positive and insignificant effect on the exchange rate variable, as indicated by the t-statistic value being less than the t-table value. Cryptocurrency prices tend to be very volatile, and massive fluctuations in the short term can lead to unstable or unclear relationships with exchange rates. The influence of this high volatility can result in insignificant outcomes, even though the direction of the influence is positive. In Table 11, in the short term, the variables of electronic money and cryptocurrency have a significant impact on the exchange rate with a t-statistic value greater than the t-table. The negative coeffecients on the cryptocurrency variable at lags 1 and 2 indicate that an increase in cryptocurrency activity also leads to a decrease in the exchange rate. Conversely, the exchange rate in the previous period shows a positive influence at lag 1 and a negative influence at lag 2, reflecting that there is an adjustment effect from previous exchange rate fluctuations. Changes in transaction volume and the use of digital instruments can affect capital flows and market perceptions of exchange rates. Electronic money can enhance liquidity and accelerate transactions, which can ultimately affect the demand and supply of domestic currency. Meanwhile, cryptocurrencies are often considered speculative assets, so their movements can affect

exchange rate volatility, especially when there are large inflows or outflows of funds related to crypto transactions.

Impulse Response Function (IRF)

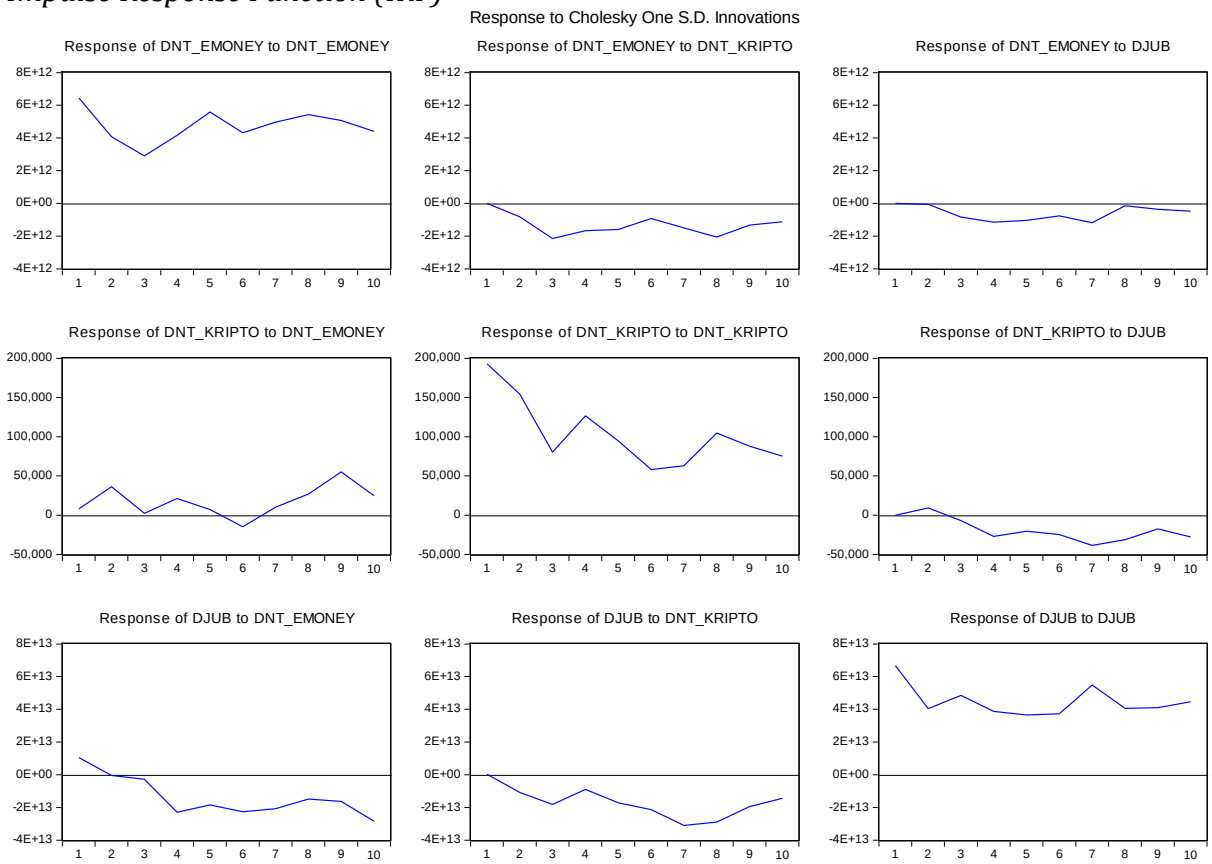


Image 5. IRF of Cryptocurrency, Electronic Money, and Money Supply (M2)

Image 5 shows the IRF of cryptocurrency and electronic money in relation to the money supply (M2). Initially, electronic money responded negatively to the shock from crryptocurrency, but in the medium term, its effects appear to be more stable. This shows that there is a significant initial influence that diminishes over time. Second, the response of electronic money to the money supply (M2) is relatively neutral to shocks in the money supply, with slight initial fluctuations but then returning to stability. Third, the response of cyptocurrency to electronic money shows that cryotocurrency positively responds to shocks in electronic money initially, but then fluctuations appear and tend to stabilize. This shows the interaction between the two payment technologies. The fourth response of cryptocurrency to the money supply (M2) shows that the response of crypto to shocks in the money supply (M2) is not very significant, with a relatively flat graph indicating a low influence. The fifth response of the money supply (M2) to electronic money shows that the money supply (M2) reacts negatively to shocks in electronic money, which may reflect a shift from conventional currency to electronic money. The sixth response of the money supply (M2) to cryptocurrency indicates that the money supply (M2) responds negatively to shocks in cryptocurrency, suggesting that an increase in cryptocurrency transactions could reduce the money supply in the conventional financial system.

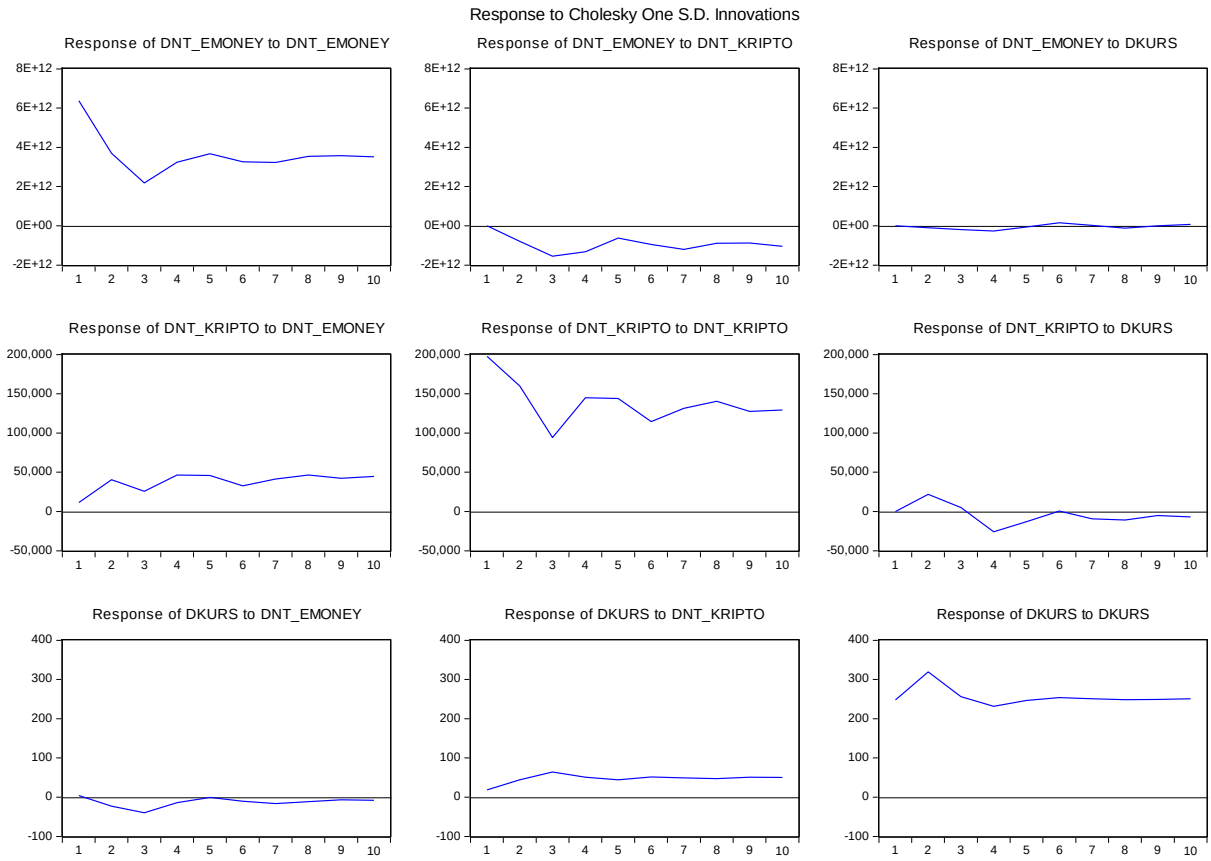


Image 6. IRF of Cryptocurrency, Electronic Money, and Exchange Rates

Image 6 shows the cryptocurrency IRF and electronic money in relation to exchange rates. First, the response of electronic money in relation to cryptocurrency, electronic money responds negatively to shocks from cryptocurrency, but its fluctuations are not significant and tend to stabilize after a few periods. This shows that cryptocurrencies have a small influence on electronic money in the short term. Secondly, the response of electronic money to exchange rates indicates the electronic money shows almost no reaction to shocks in exchange rate, meaning that changes in exchange rates do not significantly affect the use of electronic money in the short term. Thirdly, the response of cryptocurrencies to electronic money reveals that cryptocurrencies responds positively to shocks from electronic money with a fairly significant initial fluctuation before stabilizing again. This indicates a correlation between the two variables, where an increase in the use of electronic money can affect cryptocurrency in the short term. Fourth, the four response of cryptocurrencies to exchange rate shows that cryptocurrencies react positively to shocks in exchange rates, albeit with relatively small fluctuations. This indicates that changes in exchange rates can slightly affect cryptocurrency activity, but not significantly. Fifth, the exchange rate's response to electronic money shows a very weak reaction to shocks in electronic money. This indicates that the use of electronic money does not have a significant impact on exchange rates in the short term. Sixth, the response of the exchange rate to cryptocurrency shows slight fluctuations in reaction to shocks from cryptocurrency, but the response is not significant, this shows that although cryptocurrencies can influence exchange rates, their impact is relatively small in the short term.

Variance Decomposition

Table 12. Variance Decomposition Test of Money Supply (M2)

Variance Period	S.E.	UE	KRIPTO	M2
1	6.75E+13	2.397650	0.001907	97.60044
2	7.94E+13	1.735667	1.864961	96.39937
3	9.49E+13	1.299450	4.964465	93.73608
4	1.05E+14	5.797358	4.737005	89.46564
5	1.14E+14	7.530073	6.258812	86.21111
6	1.24E+14	9.704829	8.260464	82.03471
7	1.41E+14	9.724643	11.25589	79.01946
8	1.50E+14	9.534120	13.62915	76.83673
9	1.58E+14	9.708709	13.87014	76.42115
10	1.67E+14	11.55667	13.11723	75.32609

Source: Data processed by Eviews, 2024

Table 12 above shows the relative contribution of electronic money (UE), cryptocurrency (KRIPTO) and the money supply (M2) to the variation in the money supply (M2) over several periods. In the early period (period 1), the majority of the variation in the money supply was explained by itself (97.6%), while the influence of electronic money and cryptocurrency was very small. However, over time, the contributions of electronic money and cryptocurrency increased, with electronic money having a greater influence, reaching 11.56% in period 10, and cryptocurrency reaching 13.12% in the same period. Although money supply (M2) remains the dominant factor in explaining its own variation (75.33% in the 10-period), the increasing contribution of electronic money and crptocurrency indicates that in the long run, these two variables are beginning to significantly influence the money supply, reflecting their growing role in the monetary system.

Table 13. Variance Decomposition Test of Exchange Rate

Variance Period	S.E.	UE	KRIPTO	KURS
1	248.6786	0.025362	0.543441	99.43120
2	407.9222	0.318722	1.382233	98.29904
3	487.6076	0.883032	2.699870	96.41710
4	542.2932	0.777914	3.071299	96.15079
5	597.3152	0.641397	3.088500	96.27010
6	651.0535	0.565040	3.228979	96.20598
7	699.5799	0.544689	3.286780	96.16853
8	743.8864	0.504897	3.307694	96.18741
9	786.0992	0.459449	3.387185	96.15337
10	826.6909	0.425041	3.437462	96.13750

Source: Data processed by Eviews, 2024

Table 13 above shows the results of the variance decomposition of the exchange rate variable to observe the relative contributions of electronic money, cryptocurrency, and the exchange rate itself to the fluctuations in exchange rate values over several periods. In the early period, the exchange rate was heavily influenced by itself (around 99%), with minimal contributions from electronic money and cryptocurrency. However, over time, although the exchange rate remained dominant, the contribution of cryptocurrency gradually increased from 0.54% in the first period to 3.44% in the tenth period. On the other hand, the influence of electronic money remained very small, below 1% throughout the period. This indicates that exchange rate fluctuations are still dominated by their internal factors, but cryptocurrencies are beginning to have a slightly more significant impact over time, while the role of electronic money remains marginal.

CONCLUSIONS

Based on the results and discussions in the research, it can be concluded that in the Granger Causality test, there is a one-way causality between electronic money and cryptocurrency, but not the other way around. This indicates that electronic money plays a key role in cryptocurrency transactions in Indonesia, while the volatility of cryptocurrency has an unstable impact on traditional economic systems such as exchange rates. Furthermore, there is a one-way causality between the money supply (M2) and cryptocurrency, meaning that the money supply (M2) influences cryptocurrency. The results of the tests using the VECM model indicate that in the long term, electronic money has a negative and significant impact on the money supply, while in the short term, both cryptocurrency and electronic money significantly influence the money supply (M2), although their effects are dynamic and vary based on different lags. The estimation results of the VECM model with the exchange rate as the deependent variable show that in the long term, cryptocurrency does not have a significant impact on the exchange rate, whereas in the short term, both cryptocurrency and electronic money have a negative and significant effect on the exchange rate. Electronic money has a greater long-term impact on the money supply (M2), while cryptocurrency has a more significant influence in the short term. The results of the IRF indicate that the response of electronic money to shocks from cryptocurrency shows a stable negative effect in the medium term. The response of cryptocurrency to shocks in electronic money exhibits initial fluctuations but tends to stabilize, while the response of the money supply (M2) to electronic money shows a negative effect.

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